CLAIMS:

What is claimed is:

1. A sensor comprising:

an upper shell;

an outer shield disposed in physical communication with the upper shell;

a sensing element comprising a sensing electrode and a reference electrode disposed at a sensing end of the sensing element, wherein the sensing end is disposed in the outer shield; and

a sampling tube extending from the outer shield, wherein the sampling tube is configured to enable fluid communication between the sensing element and an environment external to the outer shield.

2. The sensor of Claim 1, further comprising an inner shield forming a plenum around the sensing end, wherein the inner shield allows fluid communication between the sampling tube and the sensing end and between the plenum and the outer shield.

3. The sensor of Claim 2, wherein the inner shield has a length less than an outer shield length such that an opening is formed by a space between the inner shield and the outer shield at an end of the inner shield proximate the upper shell.

4. The sensor of Claim 1, wherein the inner shield has a plurality of passages allowing exhaust fluid to enter a space between the inner shield and the outer shield, and wherein the outer shield has a plurality of holes allowing the exhaust fluid in the space between inner shield and outer shield to exit the sensor.

5. The sensor of Claim 1, wherein the sampling tube and the inner shield are a single, integral part.

6. The sensor of Claim 1, wherein the sampling tube has a diameter of about 2 mm to about 8 mm.

7. The sensor of Claim 6, wherein the sampling tube has a diameter of about 4 mm to about 5 mm.

8. The sensor of Claim 1, wherein the sampling tube has a length of about 20 mm to about 150 mm.

9. The sensor of Claim 8, wherein the sampling tube has a diameter of about 50 mm to about 100 mm.

10. The sensor of Claim 1, wherein the sampling tube extends from the outer shield from an end of the outer shield opposite the upper shell.

11. A method of making a sensor, the method comprising:

encasing a sensing end of a sensing element in an outer shield, wherein a plenum is formed around the sensing end, wherein the sensing element comprises a sensing electrode and a reference electrode disposed at a sensing end of the sensing element; and

disposing a sampling tube at an end of outer shield, wherein the sampling tube is configured to enable fluid communication between the sensing element and an environment external to the outer shield.

12. The method of Claim 11, further comprising disposing an inner shield within the outer shield, wherein the inner shield forms a plenum around the sensing end and allows fluid communication between the sampling tube and the sensing end and between the sensing end and the outer shield.

13. The method of Claim 12, wherein the outer shield has a plurality of holes capable of allowing sensing gas in the space between the inner shield and the outer shield to exit the sensor.

14. The method of Claim 12, wherein the inner shield has a length less than a length of the outer shield, wherein an opening is formed between the inner shield and the outer shield.

15. The method of Claim 11, wherein the sampling tube and the inner shield are a single, integral part.

16. The method of Claim 11, wherein the sampling tube has a diameter of about 2 mm to about 8 mm.

17. The method of Claim 16, wherein the sampling tube has a diameter of about 4 mm to about 5 mm.

18. The method Claim 11, wherein the sampling tube has a length of about 20 mm to about 150 mm.

19. The method of Claim 18, wherein the sampling tube has a length of about 50 mm to about 100 mm.

20. A method of using a sensor, the method comprising:

exposing a sampling tube disposed within a substrate to a gas to be sampled, wherein the sampling tube extends from an outer shield of a sensor into a substrate, and wherein the outer shield is located outside the substrate, and wherein the sensor comprises an upper shell, an outer shield disposed in physical communication with the upper shell, a sensing element comprising a sensing electrode and a reference electrode disposed at a sensing end of the sensing element, wherein the sensing end is disposed in the outer shield, and the sampling tube extends from the outer shield;

introducing the gas from the substrate into the sampling tube;

passing the gas through the sampling tube; and

exposing the sensing end to the gas, wherein the gas contacts the sensing end and then exits the sensor through the outer shield.

21. The method of Claim 20, further comprising flowing the gas through the sampling tube into an inner shield where the gas contacts the sensing end, and then out of the inner shield, through the outer shield, and out of the sensor, wherein the inner shield disposed around the sensing end, between the sensing element and the outer shield, and in fluid communication with the sampling tube.

22. An exhaust treatment device, comprising:

a substrate disposed within a housing;

a sensor extending through the housing, wherein the sensor comprises an outer shield disposed in physical communication with an upper shell, a sensing element comprising an electrolyte, a sensing electrode, and a reference electrode disposed at a sensing end of the sensing element, and wherein the sensing end is disposed in the outer shield, and a sampling tube extending from the outer shield into the substrate, wherein the sampling tube is configured to enable fluid communication between the sensing element and a point within the substrate.

23. The exhaust treatment device of Claim 22, wherein the substrate is selected from the group consisting of filters, catalyst supports comprising catalyst, absorber supports comprising absorbent materials, and adsorber supports comprising adsorbant materials.

24. The exhaust treatment device of Claim 22, wherein the housing further comprises an end portion comprising an end-cone, and wherein the sensor extends into the housing through the end cone.